

# COGNITIVE PROCESSES

## Agenda

- Problem solving
  - Gestalt and information processing

## Announcements

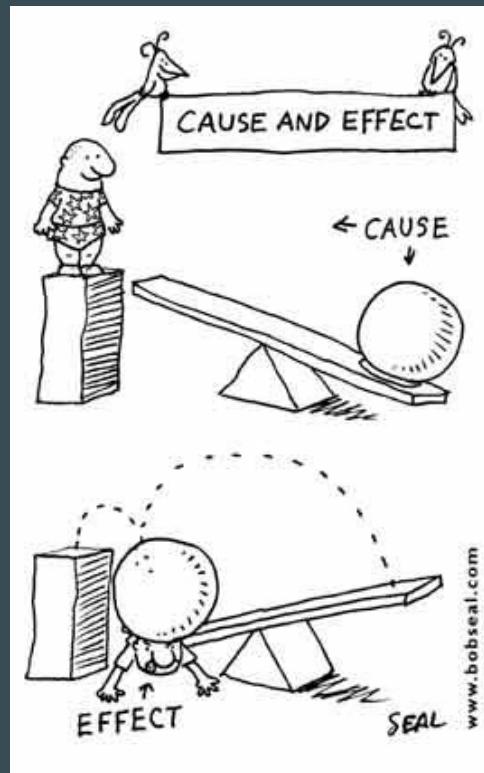
- Waiting on one person to take the exam

# Learning Objectives

1. Define a problem
2. Know evidence supporting the Gestalt approach to problem representation and restructuring
3. Information-processing approach...

# Problems

- ▶ Problems need to be identified before they can be solved



# Problems

- ▶ Problems need to be identified before they can be solved



# Problems

- ▶ Problems need to be identified before they can be solved



# Problems

- ▶ Problems need to be identified before they can be solved

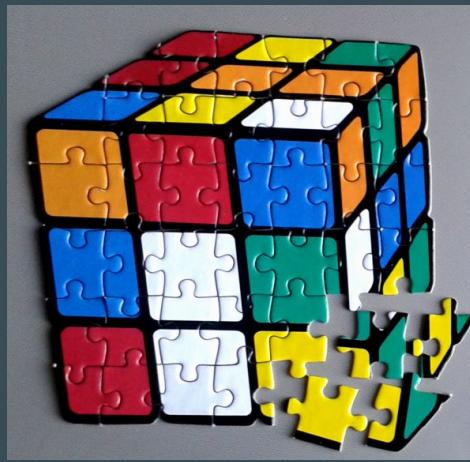
*Suppose you are a bus driver. On the first stop, you pick up 4 men and 2 women. At the second stop, 2 men, 4 women and 1 child board the bus. At the third stop, 2 men leave and 2 women get on. At the fourth stop, 3 women get off. At the fifth stop, 2 men get off, 1 man gets on, 2 women get off and 1 woman gets on. What is the bus driver's name?*

# Problems

- ▶ Problems need to be identified before they can be solved
  - 1) *I know the answer*
  - 2) *There is an answer but I don't know it*
  - 3) *There is no answer*

# Problems

- ▶ Some **well-defined** problems are easy to identify and solve



# Problems

- ▶ Other **ill-defined** problems are hard to identify and solve



# Problems

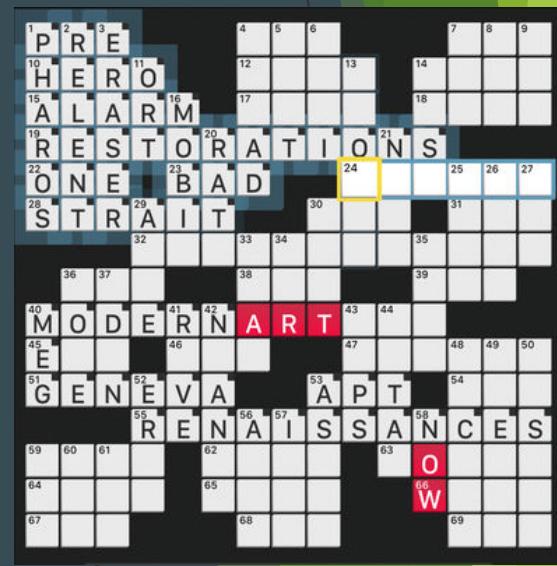
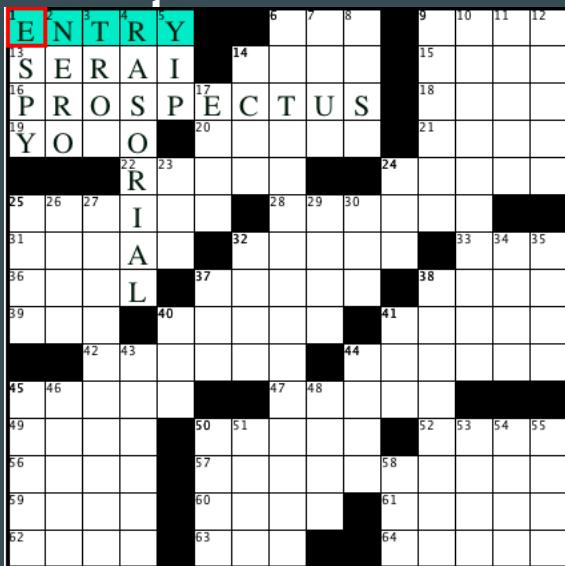
**Problem:** when there is an obstacle between a present state and a goal

# Learning Objectives

1. Define a problem
2. Know evidence supporting the Gestalt approach to problem representation and restructuring
3. Information-processing approach...

# Representing Problems

- We represent problems in our mind differently than they are presented



# Representing Problems

- We represent problems in our mind differently than they are presented



# Restructuring Problems

**Restructuring:** the process of changing a problem's representation

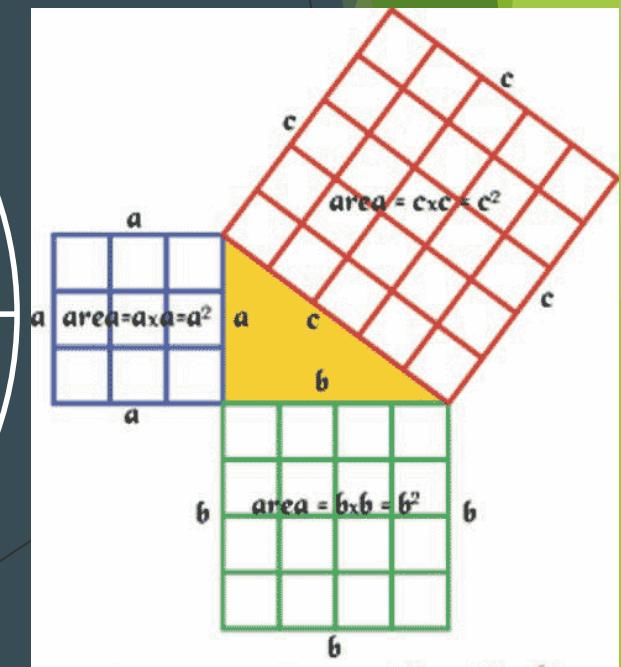
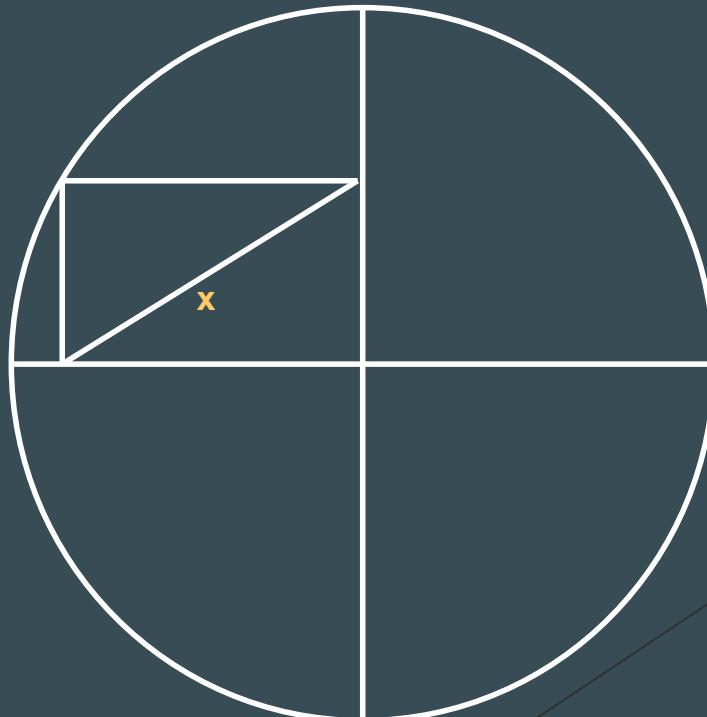
# Restructuring Problems

**Restructuring:** the process of changing a problem's representation

*A father and his son are in a car accident. The father dies instantly, and the son is taken to the nearest hospital. The doctor comes in and exclaims "I can't operate on this boy". "Why not?" the nurse asks. "Because he's my son", the doctor responds. How is this possible?*

# Restructuring Problems

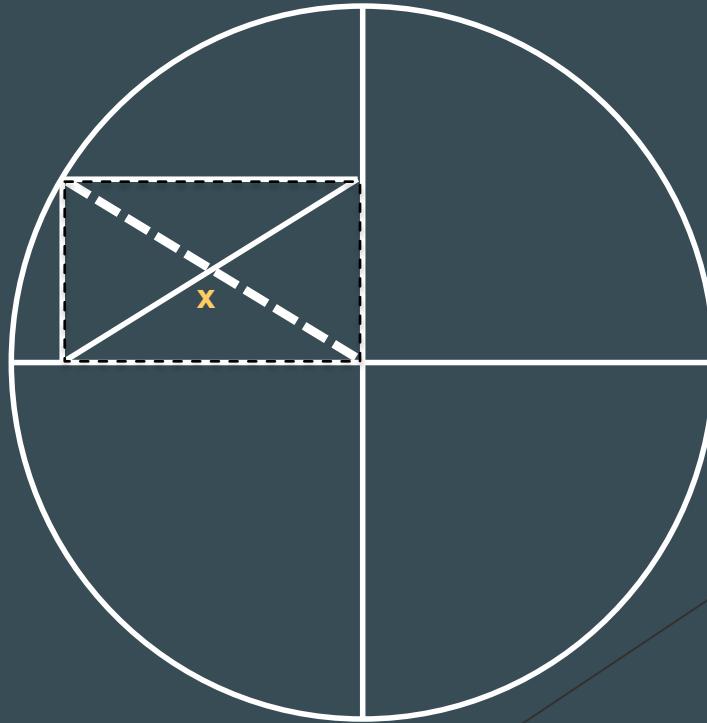
If the length of the circle's radius is  $r$ ,  
what is the length of the  $x$ ?



$$\text{Pythagorean Theorem: } c^2 = a^2 + b^2$$

# Restructuring Problems

*If the length of the circle's radius is  $r$ ,  
what is the length of the  $x$ ?*



# Restructuring Problems

*Mary is 10 years younger than twice Susan's age.*

*Five years from now, Mary will be 8 years older than Susan's age at that time.*

*How old are Mary and Susan?*

# Restructuring Problems

*Mary is 10 years younger than twice Susan's age.*

$$M = 2S - 10$$

*Five years from now, Mary will be 8 years older than Susan's age at that time.*

$$M + 5 = S + 8 + 5$$

*How old are Mary and Susan?*

$$(2S - 10) + 5 = S + 5 + 8$$
$$S = 18$$

$$M = 2(18) - 10$$
$$M = 26$$

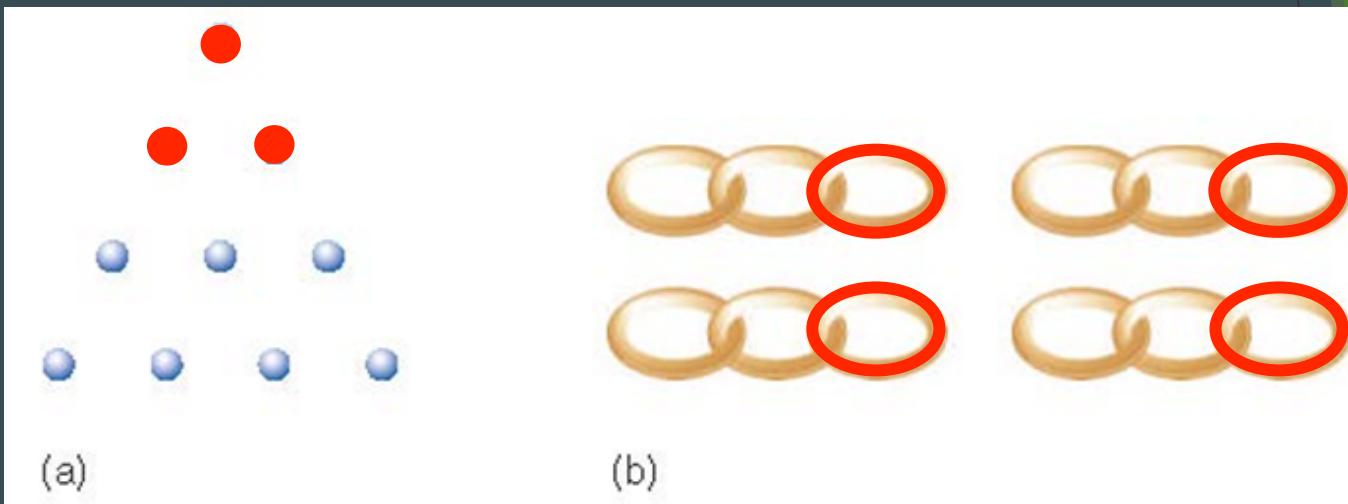
$M = \text{Mary}$   
 $S = \text{Susan}$

# Insight

**Insight:** sudden realization of a solution to a problem; often involves reorganization

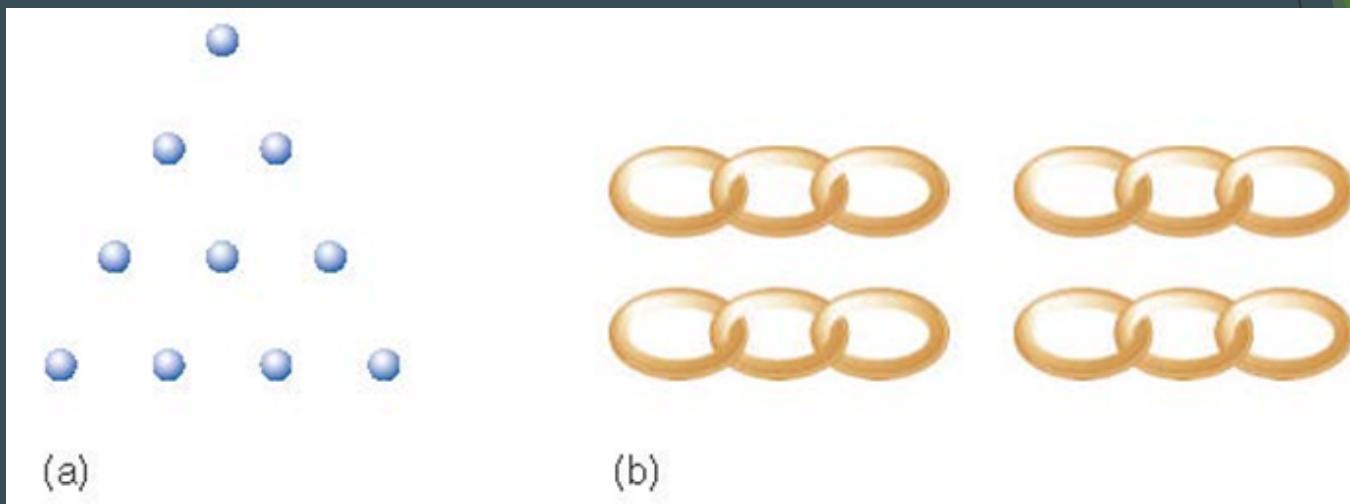
# Insight

## ► Insight problems



# Insight

## ► Insight problems



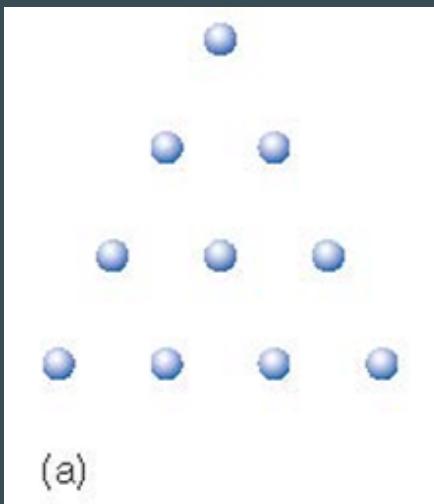
## ► Non-insight problems

Solve for  $x$ :

$$(1/5)x + 10 = 25$$

# Insight

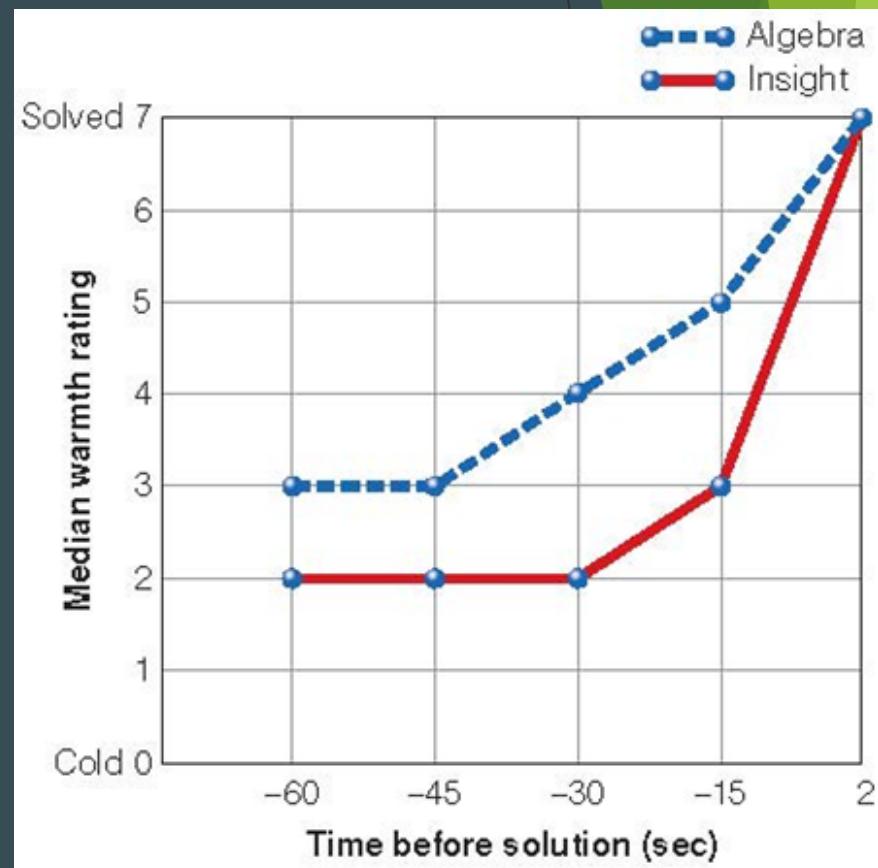
## ► Insight problems



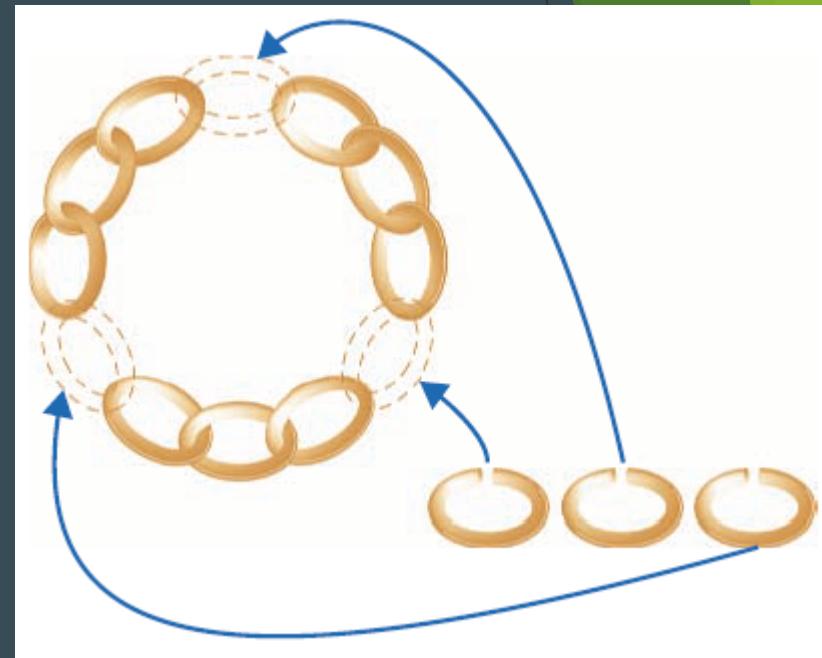
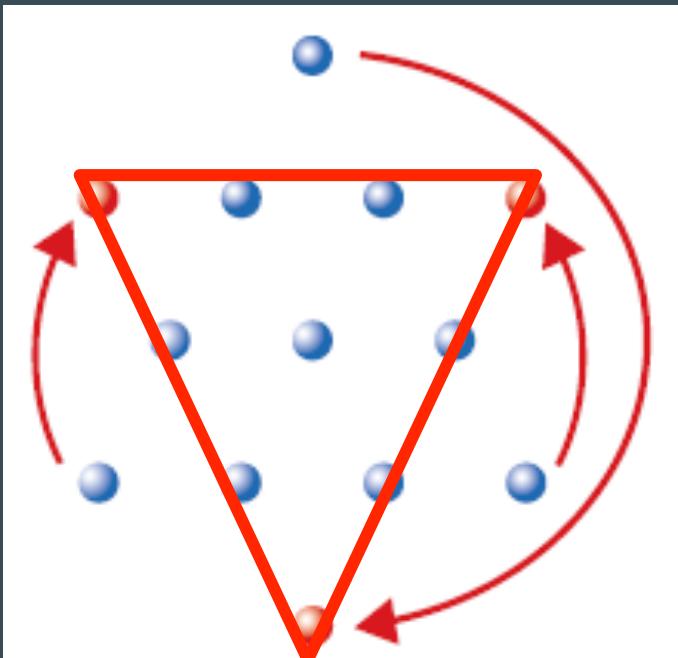
## ► Non-insight problems

Solve for  $x$ :

$$(1/5)x + 10 = 25$$



# Insight



# Functional Fixedness

**Functional fixedness:** tendency to focus on familiar functions or uses of objects

# Functional Fixedness

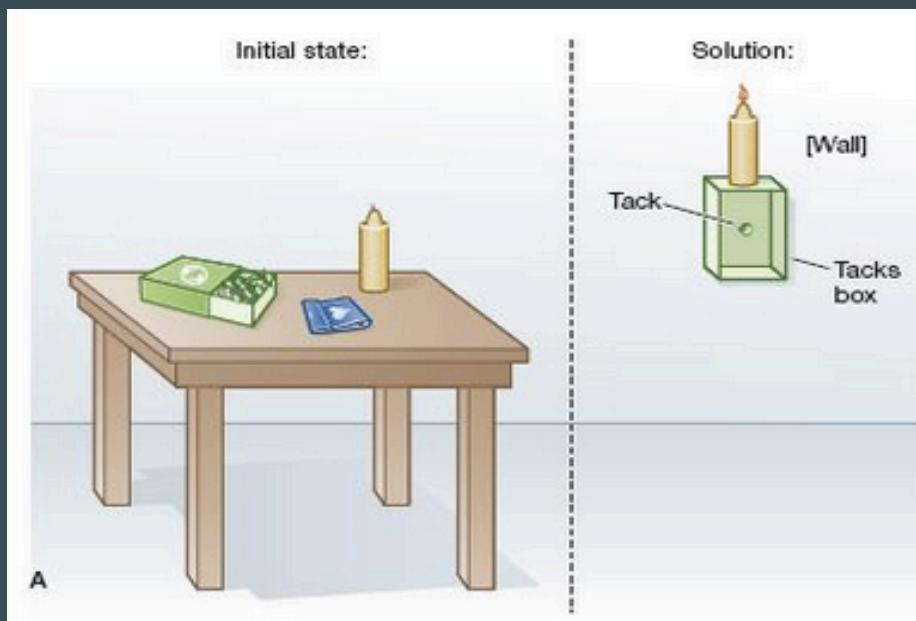
*You are in a room with a corkboard attached to the wall. You are given these materials. Your task is to mount the candle to the corkboard so it will burn without dripping wax on the floor.*



The Candle Problem

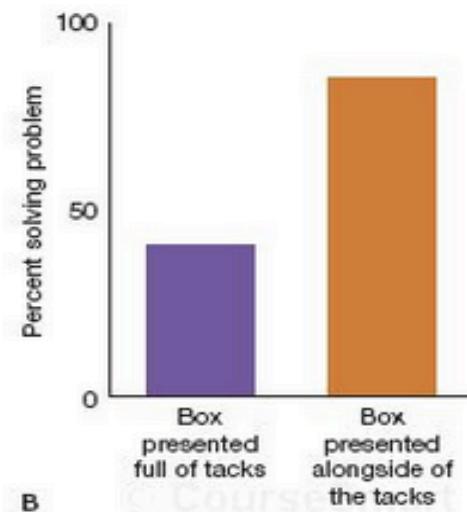
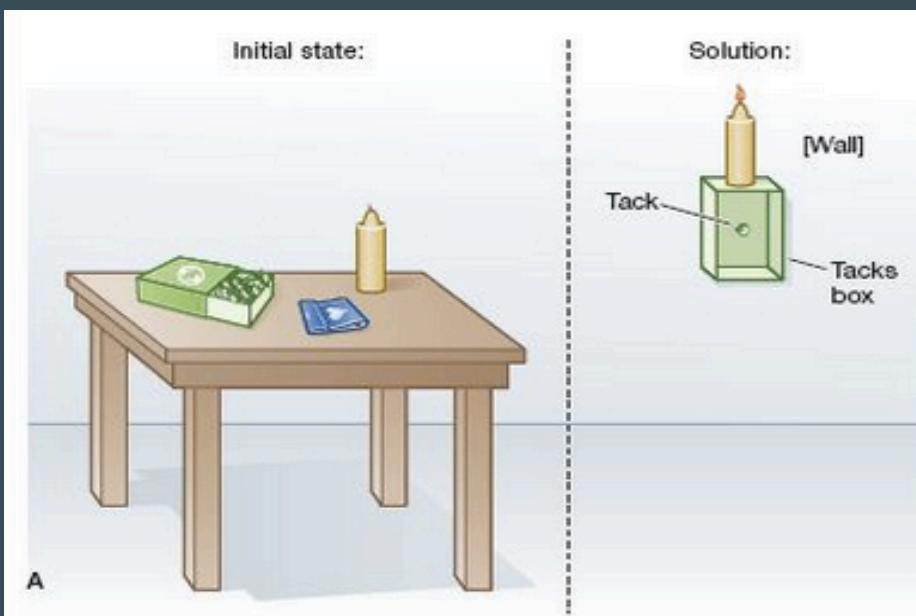
# Functional Fixedness

*You are in a room with a corkboard attached to the wall. You are given these materials. Your task is to mount the candle to the corkboard so it will burn without dripping wax on the floor.*



# Functional Fixedness

*You are in a room with a corkboard attached to the wall. You are given these materials. Your task is to mount the candle to the corkboard so it will burn without dripping wax on the floor.*



# Functional Fixedness

*Tie together the two strings hanging from the ceiling*



The Two-Strings Problem

# Mental Set

**Mental set:** preconceived notion about how to approach a problem

# Mental Set

*You have 3 empty jars. The capacity for each is noted on the jar.*

*Can you measure 5 quarts of water?*



# Mental Set

*You have 3 empty jars. The capacity or each is noted on the jar.*

*Can you measure 5 quarts of water?*

- Fill B
- Pour into A once
- Pour into C twice

$$43 - 18 - 10 - 10 = 5$$



# Mental Set

*You have 3 empty jars. The capacity or each is noted on the jar.*

*Can you measure 20 quarts of water?*



# Mental Set

*You have 3 empty jars. The capacity or each is noted on the jar.*

*Can you measure 20 quarts of water?*

- Fill B
- Pour into A once
- Pour into C twice

$$49 - 23 - 3 - 3 = 20$$



# Mental Set

*You have 3 empty jars. The capacity or each is noted on the jar.*

*Can you measure 20 quarts of water?*

- Fill B
- Pour into A once
- Pour into C twice

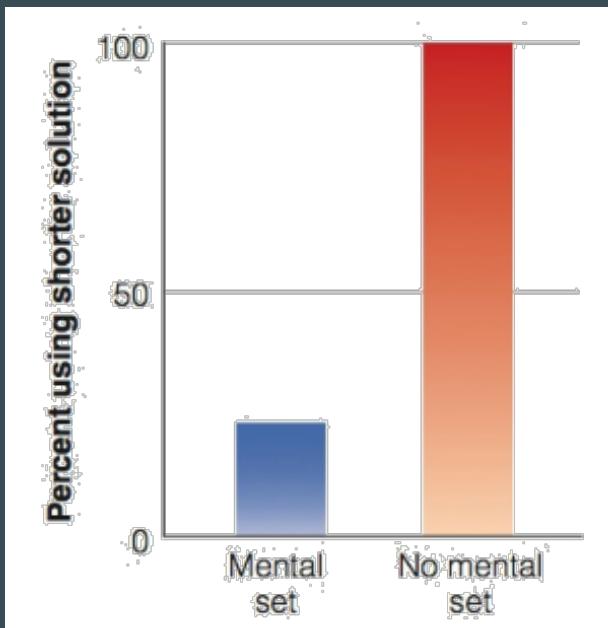
$$49 - 23 - 3 - 3 = 20$$



- Fill A
- Pour into C once

$$23 - 3 = 20$$

# Mental Set



- ▶ Water jug problem: given mental set inhibited participants from using simpler solution

# Learning Objectives

1. Define a problem
2. Know evidence supporting the Gestalt approach to problem representation and restructuring
3. Information-processing approach...

# Information-Processing Approach

**Information-processing approach:** problem solving is a search between the posing of a problem and its solution

# Information-Processing Approach

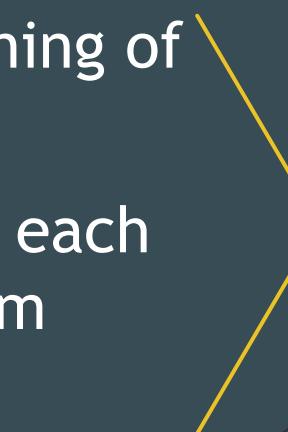
**Information-processing approach:** problem solving is a search between the posing of a problem and its solution

- ▶ **initial state:** conditions at the beginning of a problem
- ▶ **intermediate state:** conditions after each step is made toward solving a problem
- ▶ **goal state:** solution to the problem

# Information-Processing Approach

**Information-processing approach:** problem solving is a search between the posing of a problem and its solution

- ▶ **initial state:** conditions at the beginning of a problem
- ▶ **intermediate state:** conditions after each step is made toward solving a problem
- ▶ **goal state:** solution to the problem



problem  
space

# Information-Processing Approach

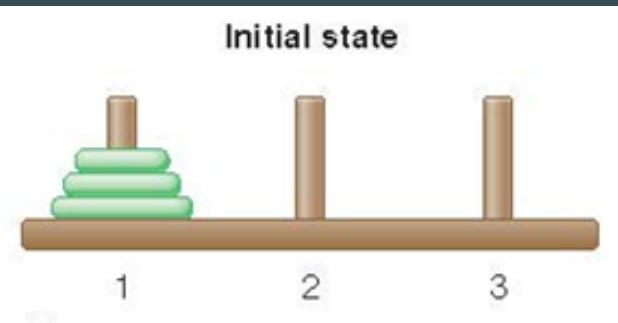
**Information-processing approach:** problem solving is a search between the posing of a problem and its solution

- ▶ **initial state:** conditions at the beginning of a problem
- ▶ **intermediate state:** conditions after each step is made toward solving a problem
- ▶ **goal state:** solution to the problem
- ▶ **operators:** actions that take the problem from one state to another



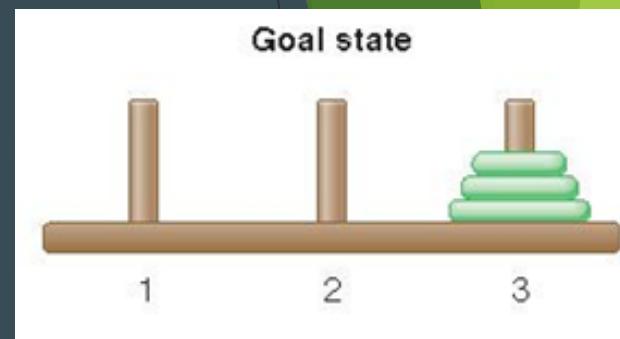
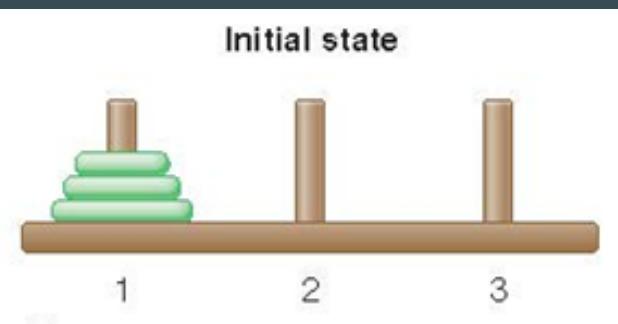
problem  
space

# Information-Processing Approach



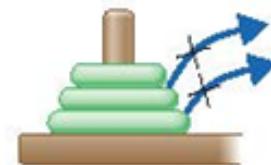
Tower of Hanoi

# Information-Processing Approach

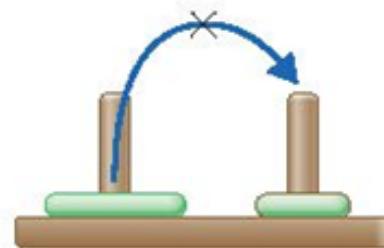


Rule 1: Move one disc at a time from one peg to another.

(b)

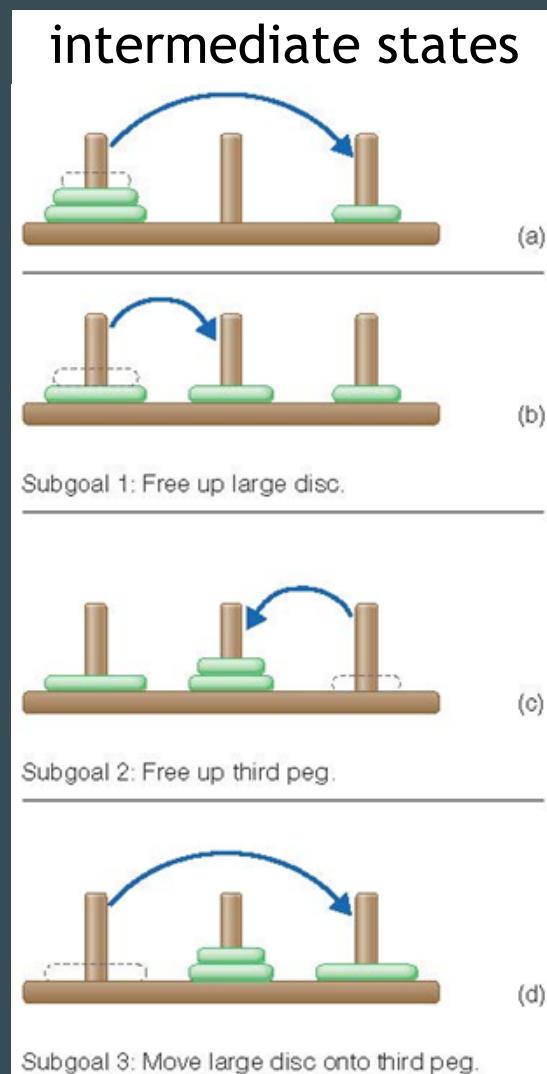
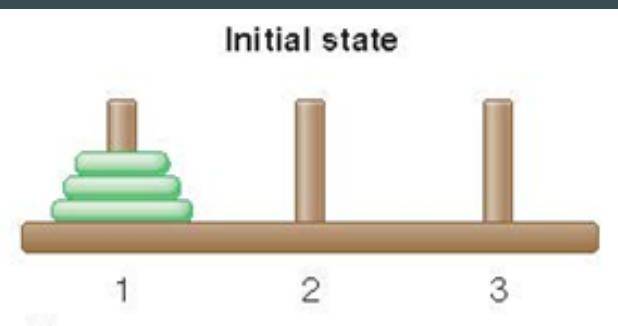


Rule 2: Can move disc only when no discs are on it.



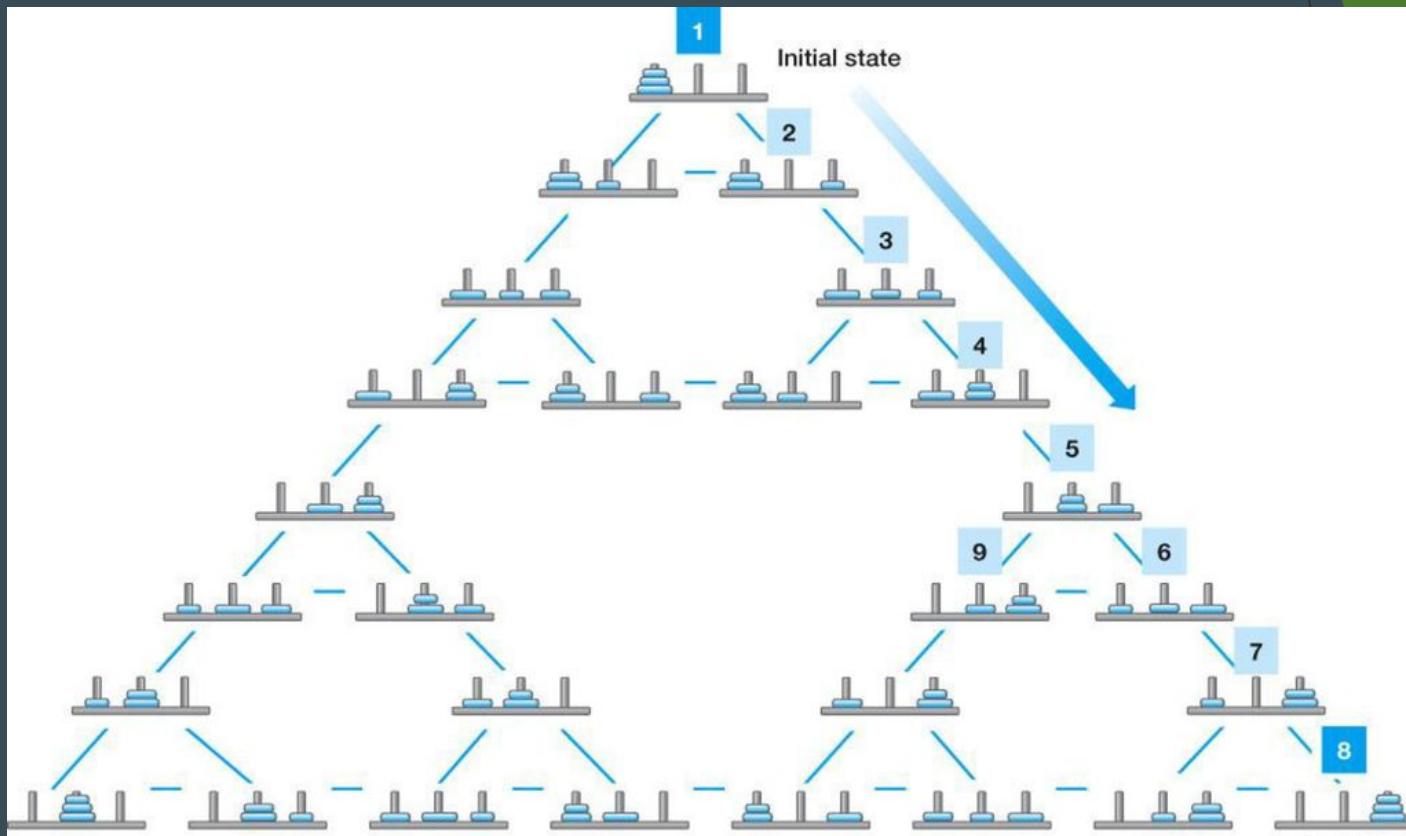
Rule 3: Larger disc cannot be put on smaller disc.

# Information-Processing Approach



Tower of Hanoi

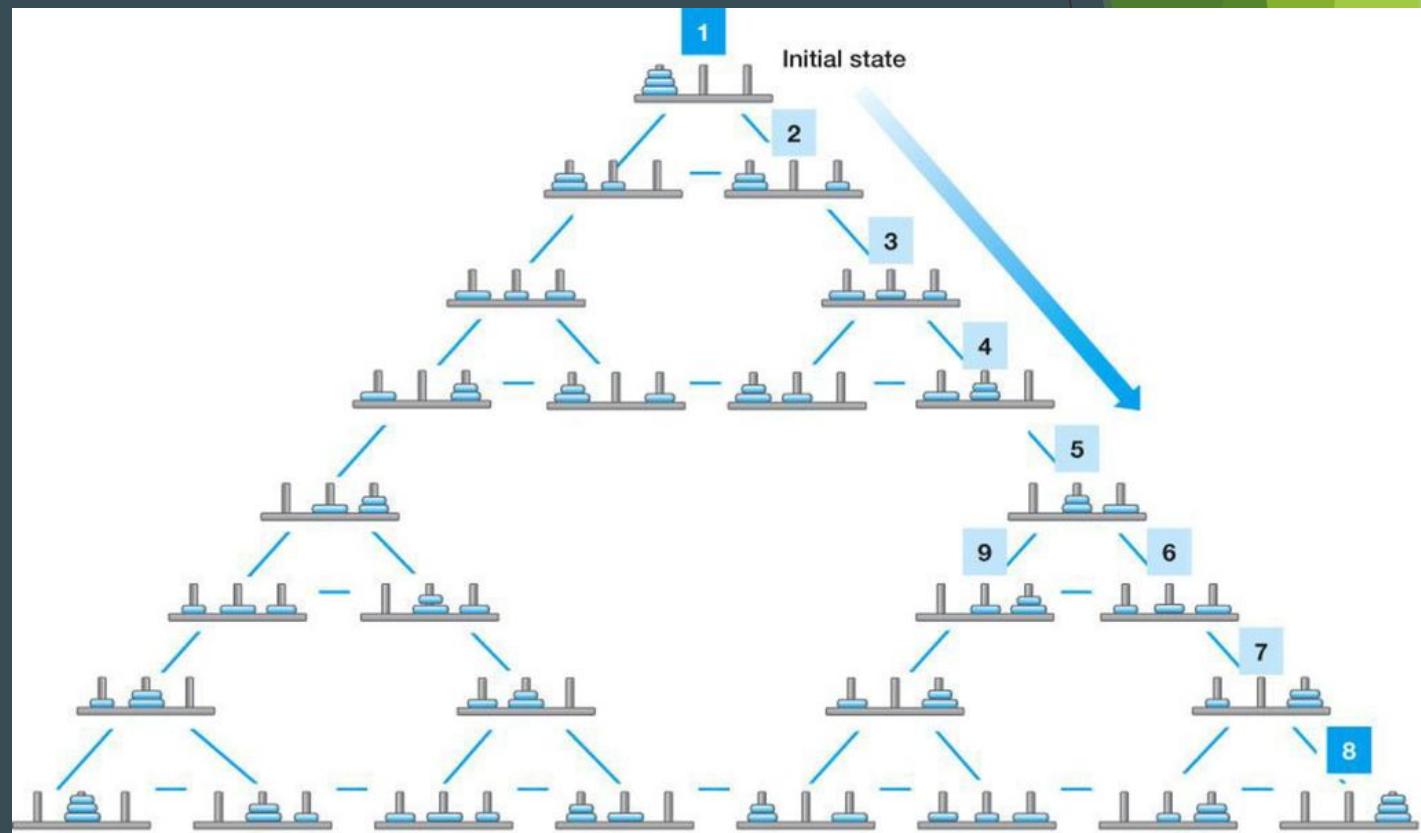
# Information-Processing Approach



Tower of Hanoi

# Information-Processing Approach

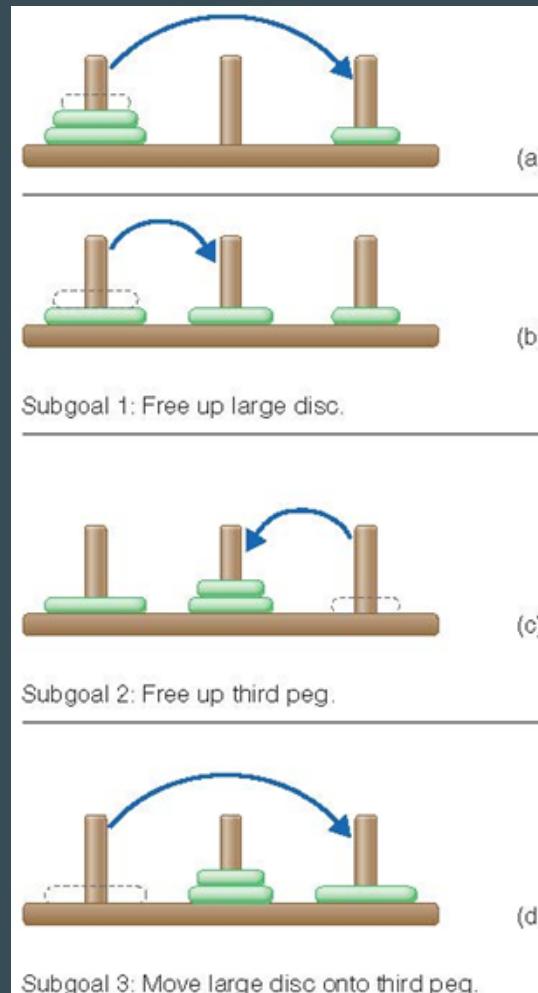
Means-end analysis:  
reduce the difference  
between the initial and  
goal states  
by creating  
sub-goals



Tower of Hanoi

# Information-Processing Approach

Means-end analysis:  
reduce the difference  
between the initial and  
goal states by creating  
sub-goals



**Subgoal 1**

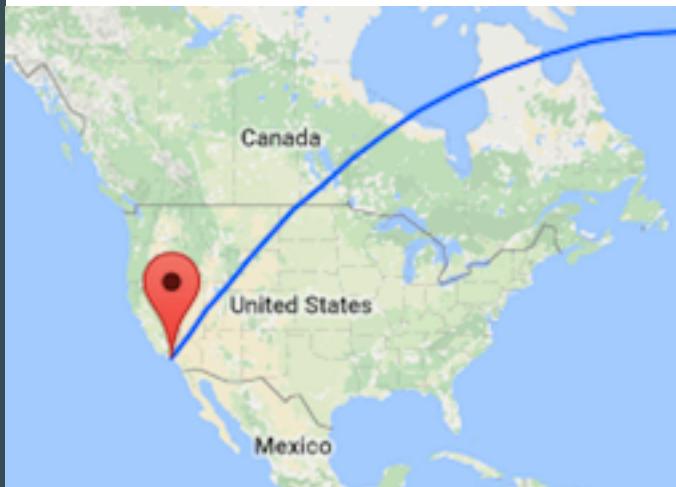
**Subgoal 2**

**Subgoal 3**

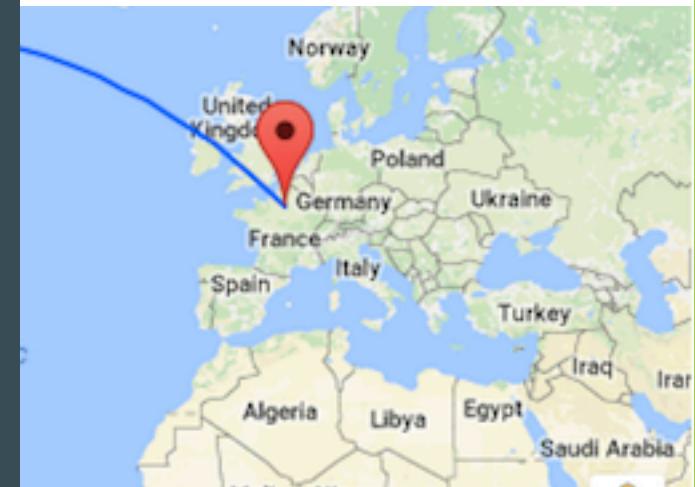
Tower of Hanoi

# Information-Processing Approach

initial state



goal state



operators

## 1) Layovers

Rule: If no direct flights, layovers must be long enough to transfer

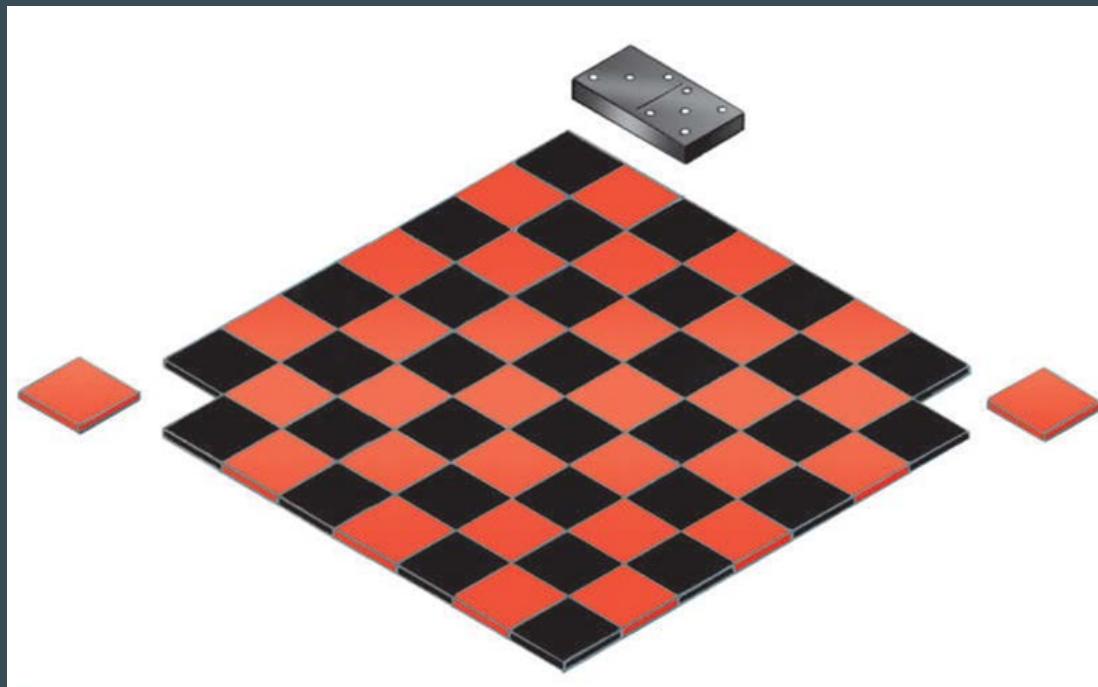
## 1) Connecting flight

Rule: Cost of the flight must be in my budget.

# Information-Processing Approach

- ▶ The information-processing approach cannot explain how the same problem space can vary in difficulty

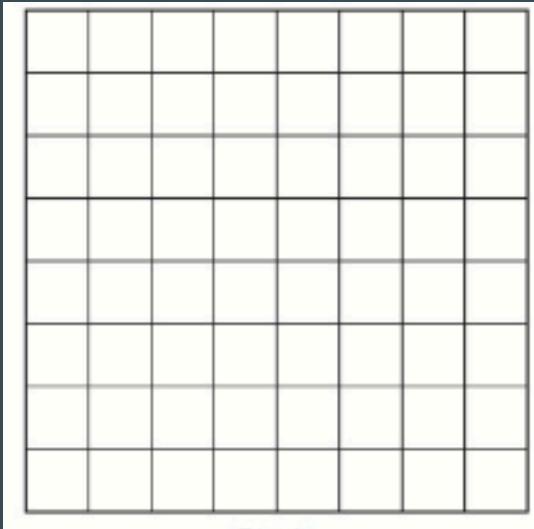
# Information-Processing Approach



- ▶ **Mutilated checkerboard problem:** If we eliminate two corners of a checkerboard, can we cover the remaining squares with dominos?

# Information-Processing Approach

Blank condition did not emphasize difference between squares



Bread-butter condition did emphasize difference between squares

butter	bread	butter	bread	butter	bread	butter	bread
bread	butter	bread	butter	bread	butter	bread	butter
butter	bread	butter	bread	butter	bread	butter	bread
bread	butter	bread	butter	bread	butter	bread	butter
butter	bread	butter	bread	butter	bread	butter	bread
bread	butter	bread	butter	bread	butter	bread	butter
butter	bread	butter	bread	butter	bread	butter	bread
bread	butter	bread	butter	bread	butter	bread	butter

- **Mutilated checkerboard problem:** If we eliminate two corners of a checkerboard, can we cover the remaining squares with dominos?

# Information-Processing Approach

## The Russian Marriage Problem

- In a small Russian village, there were 32 bachelors and 32 unmarried women. The matchmaker succeeded in arranging 32 satisfactory marriages. Then one drunken night, two bachelors, in a test of strength, killed each other. Can the matchmaker come up with 31 heterosexual marriages among the 62 survivors?

# Information-Processing Approach

## The Russian Marriage Problem

- In a small Russian village, there were 32 bachelors and 32 unmarried women. The matchmaker succeeded in arranging 32 satisfactory marriages. Then one drunken night, two bachelors, in a test of strength, killed each other. Can the matchmaker come up with 31 heterosexual marriages among the 62 survivors?

Man	Woman								
Woman	Man								
Man	Woman								
Woman	Man								
Man	Woman								
Woman	Man								
Man	Woman								
Woman	Man								

# Information-Processing Approach

- ▶ There are many paths to get from an initial state to a goal state
- ▶ We often solve problems in a step-wise manner using subgoals
- ▶ But two problems with the same problem space can vary in difficulty